

SOME FUNDAMENTAL TAXONOMIC PROBLEMS IN *FORMICA*
(HYMENOPTERA: FORMICIDAE)

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ABSTRACT

Formica bradleyi Wheeler, *F. perpilosa* Wheeler, *F. obtusopilosa* Emery, *F. manni* Wheeler, *F. oregonensis* Cole, *F. neogagates* Emery, *F. lasioides* Emery, and *F. limata* Wheeler cannot be considered properly placed in either *Raptiformica* Forel or *Proformica* Ruzsky. *F. pergandei* Emery, *F. subintegra* Emery, *F. rubicunda* Emery, *F. puberula* Emery, *F. wheeleri* Creighton, *F. curiosa* Creighton, *F. parvipappa* Cole, *F. subnuda* Emery, *F. emeryi* Wheeler, and *F. creightoni* Buren, n. sp., are all good species, and are the only Nearctic species properly placed in *Raptiformica* Forel. *Raptiformica* Forel is the only subgenus in *Formica* Linne worth retaining as a subgenus and *Proformica* Ruzsky, properly restricted to certain Palearctic species, with all Nearctic species excluded, must be considered generically distinct from *Formica* Linne. This study reaffirms in part the studies of other myrmecologists, and in part presents new data and conclusions.

Wilson and Brown (1955) synonymized *F. (Proformica) neogagates* var. *morbida* Wheeler under *F. (Raptiformica) bradleyi* Wheeler. They shifted *F. perpilosa* Wheeler, *F. obtusopilosa* Emery, *F. manni* Wheeler, and *F. bradleyi* Wheeler from *Raptiformica* to *Formica*, s. str. and sank *F. pergandei* Emery, *F. puberula* Emery, *F. rubicunda* Emery, and *F. sublucida* Wheeler under *subintegra* Emery and *F. emeryi* Wheeler under *F. subnuda* Emery. They further sank *Raptiformica* under *Formica*, s. str. and suggested that *Proformica* might be more properly considered as generically distinct from *Formica*.

Gregg (1963) has once more placed *bradleyi*, *perpilosa*, *obtusopilosa*, *oregonensis*, and *manni* in *Raptiformica* and restored *puberula*, *rubicunda*, *sublucida*, and *emeryi* to good standing. The taxonomic picture of *Formica* is still somewhat muddled in spite of these efforts and the present paper represents a third attempt to obtain some clarity.

I have points of agreement and disagreement with both Wilson and Brown on the one hand, and with Gregg on the other. My main criticism of Dr. Gregg's effort is that he has made a return to an unnatural and therefore unacceptable arrangement. By placing overemphasis on the importance of the clypeal notch as the overriding separatory character for *Raptiformica*, he may have overlooked the fact that type species of *Proformica*, *F. nasuta* Nylander, also has a weak but distinct clypeal notch. Since the clypeal notch is therefore not unique to *Raptiformica*, within the framework of *Formica*, sensu lat., the presence of this character can not be made the sole basis for a decision to include any particular species in *Raptiformica*. (I postpone, for the moment, the question of whether or not *Raptiformica* should be considered a valid subgenus.) Indeed, as I will attempt to show, there are three separate, unrelated groups, each with a clypeal notch, within *Formica*, sensu lat. To achieve a natural taxonomy within this group, it seems obvious that a study of the characteristics *in toto* rather than *in part* is more desirable.

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Another point which might be emphasized even though obvious is that any study of the subgeneric structure of *Formica* must necessarily be related to a study of the type species of each subgenus. The type species of *Raptiformica* is *F. sanguinea* Lataille (designation of Forel, 1913), and the type species of *Proformica* is *F. nasuta* Nylander (designation of Ruzsky, 1903). The American species which have been placed in *Raptiformica* and *Proformica* by various authors can only be regarded as properly placed if they show close relationships to these two species.

Upon examination, the distinctive dentition of the mandibles of *F. nasuta* is immediately striking. In all species of *Formica* from North America known to me, the mandibular dentition follows a quite definite pattern with only minor modifications. There is a large apical tooth followed by a smaller preapical tooth which is nevertheless larger than any of the remaining teeth, then a small intercalary, a median, a second small intercalary, and three basal teeth sometimes of approximately the same size as the median or often smaller. (Terminology borrowed from Wilson, 1955). This basic dentition not only holds constant throughout *Formica* including the alleged American representatives of *Proformica*, but is also the basic pattern throughout the genus *Lasius*. The dentition in *Myrmecocystus* and in many species of *Cataglyphis* is also very similar. In *F. nasuta*, however, the dentition is quite different. There is a very large apical tooth, followed by four teeth of successively gradually diminishing size, without the differentiated pattern seen in *Formica* and *Lasius*. This extremely important character casts grave doubt upon the propriety of including *nasuta* in *Formica* at all, and casts still graver doubt on the propriety of placing any American species in *Proformica*. Since the mandibular dentition is not the only unique feature of *F. nasuta*, the most casual examination of this species should show that it is not related to any of the American species that have been placed in *Proformica*. I shall return to this question, *vide infra*, after some consideration of *Raptiformica*.

The type species of *Raptiformica*, *F. sanguinea*, the well known European slave making species, has a very deep clypeal notch, and the females reflect the dulotic habits by their structure, in that the head is large, wider than the thorax, and the gaster small, shorter than the thorax. Several other features seem to be characteristic, and have already been reported in large part by Wilson and Brown. The head and thorax are reddish with the gaster black. The integument is mostly opaque and most surfaces are covered with dense pubescence. The tips of the last joints of the funniculi are noticeably flattened dorso-ventrally. The propodeum is somewhat angular in profile with the base no longer than and usually shorter than the declivity. When erect hairs are present on the propodeum they are confined to a small clump on the angle. The metanotum is small but distinct. All of the dulotic species known from either Eurasia or North America show these characters except *parcippa* Cole, which retains the structural characters but is concolorously yellowish red rather than bicolored.

The several North American species about which revolve subgeneric placement controversy, namely *F. perpilosa* Wheeler, *bradleyi* Wheeler, *obtusopilosa* Emery, *manni* Wheeler, and *oregonensis* Cole, have only the clypeal notch to recommend them toward *Raptiformica*. They are never dulotic. The females, as far as known, all use the normal claustral type of colony formation and have the usual large thorax and gaster and small head. The last

joints of the funniculi are not flattened. The propodeum is rather evenly curved in profile with the base longer than the declivity. The erect hairs of the propodeum are not confined to a clump on the angle. The metanotum is not distinct. Except in *obtusopilosa*, the pubescence is comparatively sparse and the integument is shining. In spite of the clypeal notch, it is therefore obvious that these species have only a remote relationship to *sanguinea* and cannot be considered a part of any subgenus of which *sanguinea* is the type species. Since, as I have already shown, the clypeal notch is not a unique feature in *Formica*, *sensu lat.*, the inclusion of *bradleyi* and its relatives in *Raptiformica* on the sole basis of the clypeal notch, as Gregg has done, without consideration of the discordance with the other characters of *sanguinea*, could only achieve an unnatural and untenable arrangement. *F. bradleyi*, *obtusopilosa*, *perpilosa*, *manni*, and *oregonensis*, are therefore once more returned to *Formica*, *sensu str.* As Wilson and Brown have already shown, these species are extremely close to *neogagates* Emery, *lasioides* Emery, and *limata* Wheeler, distinguishable only by the clypeal notch, which may be very feeble in some specimens. All of these species may therefore be thought of as belonging to a single species group. *F. obtusopilosa* is perhaps distinct enough to constitute a species group by itself.

So far in this paper the arguments presented have merely reinforced the 1955 views of Wilson and Brown. I cannot agree with these authors in their treatment of the *sanguinea* group, however. In spite of their obvious intensity of conviction in synonymizing a number of names in the *sanguinea* group, I must support Gregg in the resurrection of some of these names. However, Dr. Gregg's treatment lacks thoroughness, and since he has not selected lectotypes, no emergence of order out of the present chaos is likely to result.

I propose now to give an analysis of each of the species and to describe as clearly as I can how each may be distinguished from the other. For in spite of the statements of Wilson and Brown that this is a highly variable group, and that no character or combination of characters can be shown to exhibit bimodality, I find, to the contrary, that the proper combinations of separatory characters are quite stable, that the species are clearly distinguishable one from the other, and that there is no evidence of intergradation between any of the species. Nor is there any evidence that any of the separatory characters are more than usually subject to allometry. I believe that any single well preserved specimen may be sorted to species using the characters which I will elucidate, and all the members of any one nest series will exhibit the same species separatory characters. The ranges of several of the species are sympatric. In short, I can see no evidence that we are dealing with more than an ordinary taxonomic problem. I have examined all the specimens of the *sanguinea* group preserved in the Museum of Comparative Zoology and all of the specimens in the U. S. National Museum, thus, presumably, all of the material seen by Wilson and Brown, as well as all the specimens in my personal collection. In all fairness to Drs. Wilson and Brown, and to other myrmecologists who have attempted to clarify the taxonomy of the *sanguinea* group, it appears that much of the blame for the confusion rests on the original describers. In several instances, the cotype series is merely a collection of small series from several different localities and is actually a mixture of two or more species. Thus, these cotypes do not assist materially in settling points of confusion or in aiding in the attainment of species concepts. Lectotypes must now be carefully selected for several of the species

to avoid future confusion. I have attempted to select the lectotypes with the view of doing as little violence as possible to the ideas of most American myrmecologists. My revision, as finally conceived, is similar to that of Creighton (1950), with the exception of the exclusion of the misplaced *neogagates-bradleyi* group species and the new synonymy discovered by me equating *pergandei* Emery and *sublucida* Wheeler.

This revision in large part makes use of worker characteristics only. Preliminary, very incomplete studies seem to show that female and male characters would be very helpful in species diagnoses also.

1. *Formica* (*Raptiformica*) *pergandei* Emery

Formica pergandei Emery, 1893, Zool. Jahrb. Syst. 7, p. 646.

F. sanguinea subsp. *rubicunda* var. *sublucida* Wheeler, 1913, Bull. Mus. Comp. Zool., 53, p. 408.

F. (Raptiformica) sublucida Creighton, 1950, Bull. Mus. Comp. Zool., 104, p. 471.

F. (Raptiformica) pergandei Creighton, 1950, Bull. Mus. Comp. Zool., 104, p. 467.

F. subintegra Wilson & Brown (in part), 1955, Psyche, 62, p. 120.

F. sublucida Gregg, 1963, The Ants of Colorado, Univ. of Col. Press, Boulder, Col., p. 623.

The lectotype of *F. pergandei* Emery is herewith selected as specimen no. 59760 deposited in The National Museum. The lectotype of *F. sublucida* Wheeler has also been selected and is in the Museum of Comparative Zoology, Cambridge, Mass. The cotype series of *sublucida* was mixed, containing both specimens of *pergandei* (= *sublucida*, by present synonymy) and of *rubicunda* Emery (as restricted, *vide infra*). Since it is clear from Wheeler's description that he believed he had a form which is more shining than most species of the *sanguinea* group, I have selected the lectotype from that part of his cotype series which more nearly corresponds with his description.

The great difficulty in the recognition of *pergandei* has been the fact that the type series consists mostly of small or minor workers. These have the elongate, straight, or slightly concave genae which are a characteristic of the minor workers of many species throughout the genus *Formica*. This character is in no sense a species diagnostic character, and may be found in the minor workers of any large nest series of *pergandei* (= *sublucida*.) The large workers of *pergandei* invariably have the sides of the head noticeably convex with the occipital angles well rounded.

F. pergandei is one of three common species occurring in eastern North America, all of which have erect hairs on the ventral surfaces of the head and numerous hairs on the thorax. *F. pergandei* is perhaps most easily distinguished from the other two eastern pilose species by the length and structure of the erect hairs as seen under high magnification. On the dorsum of the second gastric tergite, where I have taken a number of measurements under relatively high stereoscopic magnification, these hairs are seen to be rather long for this group of species, from 0.14 to 0.25 mm. They are also somewhat flexuous and in well preserved specimens are pigmented. At the base they measure 0.008 to 0.009 mm in diameter and taper gradually to a sharp point. At mid-length they are about 0.004 mm in diameter. The high magnification appearance is thus quite different from the bristle-like gastric hairs of *subintegra* and *rubicunda* which will be described below. Other important diagnostic characters of *pergandei* are that the sides of the head

are noticeably convex with well rounded occipital corners in major workers; the scape is longer than the head (excluding mandibles) in all sizes of workers; the clypeal notch is deep; the petiolar scale is only moderately broadened seen from behind and the dorsal edge is rather blunt with indistinct or small median notch; and the surfaces are more shining than in most of the *sanguinea* group, with the genae especially smooth. The size range is about average for the *sanguinea* group.

I have seen examples of this species from the following states: District of Columbia, Virginia, North Carolina, New Jersey, Massachusetts, New Hampshire, Michigan, Illinois, and Iowa.

The species apparently occurs fairly commonly throughout the northeastern and north central states. I have not seen examples from the great plains or western mountains but it has been recorded under the name *sublucida* from the Black Hills in South Dakota and from the Rocky Mountains in Colorado. I can not vouch for the authenticity of these records but presume their correctness.

2. *Formica (Raptiformica) subintegra* Emery

Formica sanguinea rubicunda var. *subintegra* Emery, 1893, Zool. Jahrb. Syst., 7, p. 648.

F. sanguinea subintegra var. *gilvescens* ^{*u. l. + a. v. c. l.*} Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 412.

F. (Raptiformica) subintegra Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 470.

F. subintegra Wilson and Brown (in part), 1955, Psyche, 62, p. 120.

The lectotype of *subintegra* is herewith selected as type no. 69846, collected in Brookland, D. C., Feb. 1893, marked as type, var. *subintegra* by Emery, deposited in the U. S. National Museum. The lectotype of *gilvescens* Wheeler has been selected and is in the Museum of Comparative Zoology.

This species is another of the three common eastern species which have erect hairs on the ventral surface of the head and numerous hairs on the thorax. It may be distinguished from *pergandei* by its short, bristle-like, rather than long, flexuous gastric hairs. On the 2nd gastric tergite these hairs measure approximately .07 to .11 mm in length and are about .013 to .015 mm in diameter for most of their length. They taper abruptly near the tip to a sharp point or are truncated but are never gradually tapered from the base for the whole length as in *pergandei*. *F. subintegra* is perhaps more notable for the shape of the thorax. This can be more easily demonstrated by a figure (Fig. 1) rather than words. The essential characteristic appears to be that the thorax is rather "saddle-backed" with the angle between mesonotum and base of propodeum measuring approximately 135° in profile rather than the 150° or more (as in Fig 2 of *rubicunda*) which is usual in the *sanguinea* group and in most species throughout the genus. Other diagnostic characters which should be used in the identification of this species, but are not necessarily unique, are that the genae are convex in large workers, the scapes are distinctly longer than head length, the clypeal notch is rather shallow, the petiole is rather broadly fan shaped, seen from behind, but has a blunt superior edge with a usually but not always distinct median notch, the striae on the mandibles are rather weak for this group of species so that these parts are shining, and the gaster is usually dark brown rather than black.

I have seen specimens of this species from the following states: New York, Maine, Massachusetts, Pennsylvania, New Jersey, District of Columbia, Virginia, South Carolina, Tennessee, Illinois, Michigan, Wisconsin, Iowa, Kansas, and Ontario, Canada. The range is therefore sympatric with that of *pergandei* in large part. Ecological and behavioral differences probably occur but may have never been properly evaluated due to the confusion over the identity of these species.

3. *Formica (Raptiformica) rubicunda* Emery

Formica sanguinea rubicunda Emery, 1893, Zool. Jahrb. Syst., 7, p. 647; Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 406.

F. (Raptiformica) rubicunda Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 468.

F. subintegra (in part) Wilson and Brown, 1955, Psyche, 62, p. 120.

This species is the most robust of the three common eastern pilose species, the larger specimens measuring about 8.4 mm in length, with heads widths of up to 2.0 mm. Neither *pergandei* nor *subintegra* match these measurements more than very rarely. The erect hairs on the gaster are rather short and bristle-like as in *subintegra*, measuring 0.10 to 0.14 mm in length, with diameters of about 0.013 to 0.015 mm, and with the diameter constant for most of the length, and then either blunt at tip or abruptly tapering to a fine point. The hairs are thus quite different from those of *pergandei* but not from those of *subintegra*. The outline of the thorax (Fig. 2) is normal for this group of species, however, and does not have a saddle-backed appearance as in *subintegra*. In one character, namely, the shape of the petiole, *rubicunda* is different from both *subintegra* and *pergandei*. Seen from behind the petiole of *rubicunda* is broadly fan-shaped with a distinct median notch dorsally; from above, it is seen to have a sharp dorsal crest which is somewhat sinuate; in profile there is nearly always evident a slightly concave portion on the rear face just under the dorsal crest. Both *subintegra* and *pergandei* lack a sharp, sinuate crest on the petiole, the dorsal edge being blunt in each case. In *pergandei* the median notch of the petiole is faint or absent although it is usually distinct in *subintegra*. Other characters are that the integument is rather opaque in *rubicunda*, unlike *pergandei*; the genae are nearly straight or only slightly convex; the colors are usually rather dark in comparison to the other two species, with a dark red head and thorax and distinctly black gaster; and the mandibles are strongly striate, unlike the shining, weakly striate mandibles seen in *subintegra*.

I have seen examples of *rubicunda* from these states: New York, Maine, Massachusetts, Pennsylvania, New Jersey, Virginia, North Carolina, Tennessee, Indiana, Michigan, Illinois, and Iowa. This shows again a range which is sympatric with those of *pergandei* and *subintegra*. *F. rubicunda* has been recorded from the Rocky Mts. and I am presuming the correctness of these identifications.

4. *Formica (Raptiformica) puberula* Emery

F. sanguinea subsp. *puberula* Emery, 1893, Zool. Jahrb. Syst., 7, p. 648; Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 413.

F. (Raptiformica) puberula Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 468.

F. subintegra (in part) Wilson & Brown, 1955, Psyche, 62, p. 120.

The lectotype of *F. puberula* is herewith selected as type no. 69847 deposited in the National Museum. This species, like the preceding three, is perfectly distinct, but its identity has been clouded by inaccurate characterization. This species may be separated from all other *Raptiformica* species by a combination of characters.

1. The scapes are very short and quite stout, always distinctly shorter than head length.

2. The pubescent hairs on the scapes are nearly always suberect to subappressed or decumbent rather than appressed.

3. The head in large workers is trapezoidal in shape, and the occipital and genal borders are nearly straight.

4. The erect hairs have the same arrangement and are nearly as numerous as in *pergandei*. The hairs on the gastric dorsum are long, slender, and gradually tapering to a sharp point as in *pergandei*.

5. The petiole is blunt above but usually has a deep notch. Seen from behind the evenly curving upper border and deep median notch often give a distinctly heart-shaped appearance. If the notch is absent then the petiole usually has a truncated appearance.

6. The eyes are normal in size and do not usually meet the sides of the head in full face view.

The pilosity character and shape of petiole seem to show that this species is fairly closely related to *pergandei* and will serve to distinguish *puberula* easily from the species with short bristle-like hairs, *rubicunda* and *subintegra*, and from species with sparse pilosity such as *subnuda*. The short scapes with decumbent pubescence and the straight sided head will easily distinguish *puberula* from *pergandei* in which the scapes are always longer than the head length and the genae are convex in large specimens. Both *wheeleri* and *curiosa* have large protuberant eyes unlike *puberula*. The decumbent pubescent hairs on the scapes of *puberula* is a character concerning which there has been some controversy. After examining all the material available I must side with those who believe it to be a character unique to this species and nearly always present. Both *wheeleri* and *curiosa* have rather short scapes also but the pubescence on the scapes is always appressed.

I have seen examples of *puberula* from the following states: North Dakota, South Dakota, Montana, Idaho, Washington, Wyoming, Colorado, and New Mexico. The range is largely but not entirely allopatric with respect to the three common eastern species already treated.

5. *Formica (Raptiformica) wheeleri* Creighton

F. wheeleri Creighton, 1935, Amer. Mus. Nat. Hist. Novitates, No. 773, p. 1

F. (Raptiformica) wheeleri Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 472

F. wheeleri (in part) Wilson and Brown, 1955, Psyche, 62, p. 125

The holotype of *F. wheeleri* is in the American Museum of Natural History, New York, N. Y.

This species is notable for the small size of the females, which are usually no or very little larger than the larger workers. Unfortunately for identification purposes, this character, although apparently constant within *wheeleri*, so far as may be judged from the limited examples available, is not unique to this species. *F. puberula*, although usually with normal sized females, seems occasionally to have small, microgynous-like females, if my interpretation of the identity of several small females seen in the Museum of

Comparative Zoology collection is correct. Since *puberula* is closely related to *wheeleri*, an overdependence on the female size as a separatory character may lead toward occasional confusion. *F. wheeleri* is another of the species which have a pilosity pattern and the individual hair structure very similar to that of *pergandei*. A combination of characters will distinguish *wheeleri* from both *puberula* and *pergandei*:

1. The eyes are large in *wheeleri*, their longest diameter measuring about one-third the length of the head. They always interrupt the lateral borders of the head and are rather protuberant. In *pergandei* and *puberula* the eyes are more normal in size, measuring less than one-third the length of the head, rarely reach the lateral borders, and are flattened as is more usual in this group of species.

2. The head is usually a little longer than broad in *wheeleri*, with slightly convex sides, whereas in the larger specimens of *puberula* the head is as broad as or broader than long, with straight sides which converge toward the front.

3. The scapes are short, a little shorter than head length, and their pubescence is closely appressed. In *puberula* the scapes are short and stout and nearly always have subappressed or decumbent pubescence. In *pergandei* the scapes are slender and are distinctly longer than the head and have appressed pubescence.

4. The head of *wheeleri* appears to be always (all specimens known, at least) distinctly darker than the thorax. In *puberula* the head is light, as is the thorax. In *pergandei* the colors are usually darker than in *puberula* but the head is not darker than the thorax.

5. The petiole is fan shaped seen from behind as in both *pergandei* and *puberula*, but the median notch is usually weak or absent or the crest is convex seen from behind. The heart shaped or truncate appearance usually characteristic of the petiole of *puberula* is thus not seen in *wheeleri*. In profile the crest is blunt above in all three species.

I have seen only a few authentic examples of this species besides the types from the Blue Mts. and the La Sal Mts. in Utah. These records are from Florissant, Colo., Wheeler, 1906, and Raton, N. Mex., Brues, 1935. The other material identified as *wheeleri* at the Museum of Comparative Zoology, including several other series collected at Florissant by Wheeler, a Yellowstone Nat. Pk. series collected by Wilson, and a Cimarron, N. Mex. series collected by A. C. Cole, are misdeterminations and are *puberula* rather than *wheeleri*. Thus, some of the impressions which Wilson and Brown have drawn from these specimens now appear questionable.

6. *Formica (Raptiformica) curiosa* Creighton

F. curiosa Creighton, 1935, Amer. Mus. Novitates, no. 773, p. 5

F. (Raptiformica) curiosa Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 464

F. curiosa (in part) Wilson and Brown, 1955, Psyche, 62, p. 123

The holotype of *F. curiosa* is in the American Museum of Natural History, New York, N. Y. This species is closely allied to *wheeleri* and probably to *puberula*. The eyes are large and protuberant and are laterally placed as in *wheeleri*. The sides of the head are strongly convex. The erect hairs have the same arrangement and are slender and tapering as in *puberula*, *wheeleri*, and *pergandei*. I have not made differential counts, but my impression is that the erect hairs are distinctly sparser than in these three species, and

especially *pergandei*. The scapes are short as in *puberula* and *wheeleri*. The pubescence on the scapes is appressed. The head is not noticeably darker than the thorax unlike *wheeleri*. The clypeal notch is feeble rather than deep as in *puberula*, *wheeleri*, and *pergandei*.

In one character *curiosa* seems to unique. The petiole, seen from behind, is only narrowly fan shaped and the dorsal crest is moderately sharp and angularly convex without trace of a median notch in any of the specimens seen. The female is also very distinctive in being concolorous throughout, the gaster no darker than the head and thorax.

This species is only imperfectly known. Other than the co-type series from Flathead Co., Mont., I have seen only one record definitely assignable to this species — two specimens from Fairview, B. Col., E. R. Buckell, collector, without further data. These are in the M.C.Z. collection.

Other specimens in the M.C.Z. assigned to *curiosa* appear to be misdeterminations and may have led Wilson and Brown to their questionable diagnosis of this species.

7. *Formica* (*Rapiliformica*) *parcipappa* Cole

F. parcipappa Cole, 1946, Ann. Ent. Soc. Amer., 39, p. 616

F. (Raptiformica) parcipappa Creighton, Bull. Mus. Comp. Zool. Harv., 104, p. 467

F. parcipappa Wilson and Brown, 1955, Psyche, 62, p. 125

This species is unique in that the gaster is concolorous yellowish red with the head and thorax in the worker. In another characteristic it appears to be closely related to *wheeleri* and *curiosa* in that the eyes are large and protuberant and laterally placed. The pilosity, in so far as hair structure is concerned, is as has been described for *pergandei*, *puberula*, *wheeleri*, and *curiosa*. The scape length is intermediate between *puberula* and *pergandei* in being about equal to head length or only slightly longer. All surfaces are opaque in this species. The pilosity is rather sparse on the head in the two examples I have seen. There are no erect hairs behind the eyes and the venter of head was devoid of erect hairs in one specimen and the other specimen had only a single hair present. On the thorax, petiole and gaster, however, the erect hairs are about as numerous and have the same arrangement as in the other related species. The petiole of this species is rather broadly fan shaped seen from behind. The crest has a sharp edge, and there is a distinct median notch in the specimens seen.

F. parcipappa is known only from the type series, to my present knowledge.

8. *Formica* (*Raptiformica*) *subnuda* Emery

F. sanguinea rubicunda var. *subnuda* Emery, 1895, Zool. Jahrb. Syst., 8, p. 335

F. sanguinea subsp. *subnuda* Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 409

F. sanguinea subsp. *aserva* Forel, 1901, Ann. Soc. Ent. Belg., 45, p. 395; Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 404

F. (Raptiformica) sanguinea subnuda Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 469

F. subnuda Wilson and Brown, 1955, Psyche, 62, p. 118

F. (Raptiformica) sanguinea subnuda Gregg, 1963, The Ants of Colorado, p. 618

The lectotype of *subnuda* has been selected from Emery's type material in the Museum of Comparative Zoology. This species can be separated from

all of the preceding species by the sparseness of the pilosity. There are only a few erect hairs on the upper surfaces of the head, none on the ventral surfaces ("gula" of authors), a few short hairs or none on pronotum, none or very few on mesonotum and propodeum, and are sparse to moderate on the gaster. Those hairs on the pronotum are very short and blunt and those on the gaster are also rather short and either blunt or only feebly tapering.

There would seem to be no necessity for considering *subnuda* as a subspecies of *sanguinea*. The ranges are entirely allopatric and they differ both in morphology and in habits. *F. sanguinea* regularly conducts slave raids and has slaves in its nests. *F. subnuda* usually lives without slaves in the larger colonies although the slave making habits are not lost in this species. In comparative morphology, the clypeal notch of *sanguinea* is deep whereas it is rather shallow in *subnuda*; the scapes are slightly shorter than head length in *sanguinea*, longer than head length in *subnuda*. The crest of the petiole is blunt in *sanguinea*, rather sharp in *subnuda*. The integument is in general more opaque in *sanguinea* than in *subnuda*, especially on genae and gaster. The erect hairs on the gaster are shorter and blunter in *sanguinea* than in *subnuda*.

I have examined material from New Hampshire, Maine, Massachusetts, New York, Minnesota, North Dakota, Montana, Utah, New Mexico, Nevada, Alaska, Oregon, Idaho, California, Nova Scotia, New Brunswick, Manitoba, Ontario, Alberta, and British Columbia.

9. *Formica (Raptiformica) emeryi* Wheeler

F. emeryi Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53, p. 419

F. (Raptiformica) emeryi Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104, p. 464

F. subnuda (in part) Wilson & Brown, 1955, Psyche, 62, p. 118

F. (Raptiformica) emeryi Gregg, 1963, The Ants of Colorado, p. 606

The lectotype of *emeryi*, a winged female, has been selected from the original cotype series deposited in the Museum of Comparative Zoology.

Although *emeryi* is close to *subnuda* Emery, I can not follow Wilson and Brown in the sinking of this name. Gregg has resurrected the name in his "The Ants of Colorado," but the scientific basis of this resurrection is not apparent from his writings. The question is, of course, made difficult by the small number of specimens in the type series and the rather small size of the specimens, leading to the suspicion that they may be merely small examples of *subnuda*. Also the transverse impression on the base of the propodeum, which was singled out as a diagnostic character by Creighton, is probably an artifact, as suggested by Wilson and Brown. Nevertheless, *subnuda* is a well known species, well represented in museum collections, and an examination of the smaller specimens will show that they do not correspond with *emeryi*. The short, stout scapes (shorter than head length), a character emphasized by Creighton, is a very real diagnostic character which is not seen in the workers of *subnuda* of any size. The scapes in the latter species are rather long and slender throughout the size range and are distinctly longer than head length in the smaller workers. Moreover, the mandibles are much more smooth and shining in *emeryi* than in *subnuda*, and the erect gastric hairs are noticeably longer. The petiole is narrowly fan shaped in *emeryi* and the crest is rather blunt. The petiole is broadly fan shaped in *subnuda* and the crest is sharp.

The females of *emeryi* seem perfectly distinct from those of *subnuda* and this is the reason why I have chosen a female to be the lectotype. The differences are that the scapes are notably short in the female of *emeryi*, only about three fourths the head length, whereas they are only slightly shorter than head length in *subnuda*. The mandibles are very smooth and shining in *emeryi* whereas they are coarsely striate in *subnuda* females. The petiole of the *emeryi* female is narrowly fan shaped, very broadly fan shaped in *subnuda*. The whole body has a more slender appearance in *emeryi*, with the scutellum longer than broad in *emeryi*, broader than long in *subnuda*. The colors also seem to be different, at least in the known specimens, and one of the essential differences is that reddish tints appear to be absent in *emeryi*. The head is dark brown except for the yellowish mandibles and scapes. The thorax and petiole are yellow and the gaster is brown and is usually slightly lighter than or no darker than the head. In *subnuda* the head and thorax are dark reddish brown with often the head, and sometimes the thorax, infuscated, and the gaster is black.

F. neogagates is recorded as being the host of *F. emeryi*. Other than the type series, I have been unable to find additional specimens in any of the existing collections.

10. *Formica (Raptiformica) creightoni* Buren, n. sp.

Three small series, one collected by me near Bevington, Iowa, June 14, 1941, one collected by Dr. William M. Wheeler, August 14, 1902, at Rockford, Ill., and one collected by Dr. Mary Talbot in the E S. George Reserve, Livingston Co., Mich., Aug. 9, 1954, represent a distinct undescribed species previously unrecognized. A holotype has been selected from the Iowa specimens and will be deposited in the National Museum. Bevington, Iowa therefore becomes the type locality. All other specimens in the Iowa, Illinois, and Michigan material have been marked as paratypes and will be deposited in the Museum of Comparative Zoology, with a few paratypes retained in my personal collection.

The most conspicuous feature of this new species concerns the shape of the head, which is distinctly longer than broad, with straight or only feebly convex sides and straight or slightly concave hind border (Fig. 3.); This elongate, narrow head shape might be expected to occur in the minor workers of some of the species, but this is one of the few species with the known specimens in the 5.8 to 7.4 mm size range which has this character. In *subintegra* specimens of this size range, the head is slightly longer than broad, but the sides are distinctly convex, and the scapes are distinctly longer than the head.

Other than this feature, the other characters of *creightoni* show many points of similarity and dissimilarity to the other North American species.

1. In pilosity, there are erect hairs on the venter of the head ("gula") and fairly numerous hairs on the thorax as in *subintegra*, but the hairs on the gaster are more sparse than in *pergandei*, *subintegra*, *rubicunda*, or *puberula*, and are more similar to the condition in *subnuda* and *emeryi*. In actual count, there are about 25 to 40 hairs on the dorsum of the second gastric tergite in *creightoni*, while there are about 70 to 90 on this same area in *subintegra*. Moreover, although the gastric hairs of *creightoni* are short as in *subintegra* and *rubicunda*, high power magnification shows that they taper from base to pointed apex rather than being cylindrical as in these species. Again, this is more like the condition in *subnuda* than like *subintegra* and

rubicunda on the one hand or *pergandei*, *puberula*, *wheeleri*, *curiosa*, and *parcippappa* on the other.

2. The thorax in profile is somewhat "saddle-back-like" and is more similar to the condition in *subintegra* than to any other North American species.

3. The scapes are as long as or slightly longer than head length in spite of the elongate head, but are not as long, proportionately, as in *subintegra*.

4. The petiole is rather broadly fan shaped, seen from behind, but the usual median notch appears to be absent. The crest is rather blunt.

5. The mandibles are only feebly striate and are quite shining as in *subintegra* and *emeryi*.

6. The integument of the head and gaster is similar to *subnuda* in being subshining. This effect is also enhanced by the pubescence, which is composed of very short, inconspicuous, appressed hairs which are sparse on the head and which are very short and do not have much overlap on the gaster so that the integument is more visible than in most species—again more like the condition in *subnuda* than in the more opaque and more conspicuously pubescent species such as *subintegra*, *rubicunda*, and *parcippappa*.

7. The colors are dull in this new species, more brownish than reddish and with the head distinctly darker than the thorax as in *subnuda*, *emeryi*, and *wheeleri*. The gaster is black.

8. The clypeal notch is rather weak and shallow.

Both the Rockford, Ill. and the E. S. George Reserve, Mich., specimens are accompanied by slave workers. These are *F. neogagates* Emery in each case. On the same pin with the Rockford, Ill., specimens is a small male which in all probability must be the male of *creightoni*. Although I have not studied the males of *Raptiformica* in any depth, this male does appear unusual and leads to the suspicion that the unknown female of *creightoni* may also be unusual, possibly microgynous. This male is only 5.0 mm long and is rather slender. This is only about one half the length and probably only one eighth the bulk of males of species such as *rubicunda*, *subintegra*, and *subnuda*. The pubescence seems shorter and sparser than on most males, not hiding the more shining surfaces. The dorsum of the thorax is beset with short, fine, erect hairs. These are nearly absent on the gaster. The petiole is subrectangular seen from behind, not at all fan shaped, but with moderately convex sides and weakly concave superior border.

The species is named in honor of Dr. William S. Creighton, who I believe has done more than any other recent myrmecologist toward bringing good taxonomic order to much of the North American ant fauna.

The following key may prove useful in separating the nearctic species of *F. (Raptiformica)*

1. Erect hairs present on venter of head ("gula" of authors) and are usually numerous on pronotum, mesotum, crest of petiole, gaster, and often on angle of propodeum 2

No erect hairs on venter of head, and very sparse or absent on thorax and sparse on gaster 9

2. Head noticeably longer than wide (Fig. 3) and with nearly straight sides; erect hairs on gaster short and sparse, pubescent hairs sparse and the integument subshining on head *creightoni*, n. sp.

Without this combination of characters, either the gastric hairs short and bristle-like or long, flexuous, and tapering but in either case, numerous;

head in medium sized and large workers as broad as or broader than long, or sides of the head notably convex 3

3. Erect hairs of thorax and gastric dorsum short and bristle-like (.07 to .14 mm), of the same diameter for greater part of length, then either truncate or abruptly tapering to a fine point as seen under high magnification 4

Erect hairs longer and flexuous, gradually tapering from base to finely pointed apex throughout the whole length 5

4. Thorax "saddle-backed" (Fig. 1); petiole with blunt crest; mandibles weakly striate and shining; gaster usually brown *subintegra* Emery.

Thorax of usual shape in the subgenus (Fig. 2); crest of petiole sharp and sinuate; mandibles strongly striate; gaster black *rubicunda* Emery

5. Gaster yellowish red, concolorous with the thorax and head

parcipappa Cole.

Gaster black or dark brown, strongly contrasting in color with the thorax and usually the head 6

6. Eyes large and protuberant, their longest diameters approximately one-third the length of the head, always interrupting the lateral borders of the head in full face view 7

Eyes of more usual size in the subgenus, less than one-third head length, flattened and not interrupting lateral borders of head in full face view 8

7. Head distinctly darker than thorax; petiole with blunt crest, rather broadly fan shaped seen from behind, sometimes with median notch.....

wheeleri Creighton.

Head concolorous with thorax, petiole only narrowly fan shaped seen from behind, angularly convex above and the crest rather sharp, without median notch *curiosa* Creighton.

8. Head of large workers trapezoidal, with straight posterior and straight sides converging anteriorly; scapes short and robust, shorter than head length and the pubescent hairs on scapes decumbent to suberect at least in part *puberula* Emery.

Head of medium sized to large workers with convex sides and rounded hind corners; scapes long and slender, longer than head length, and with the pubescence on the scapes always entirely appressed *pergandei* Emery.

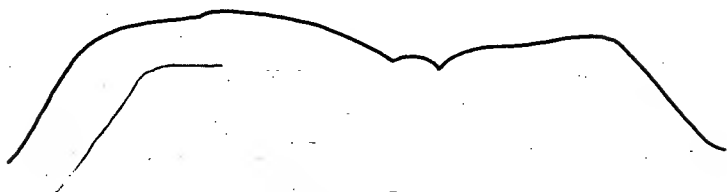
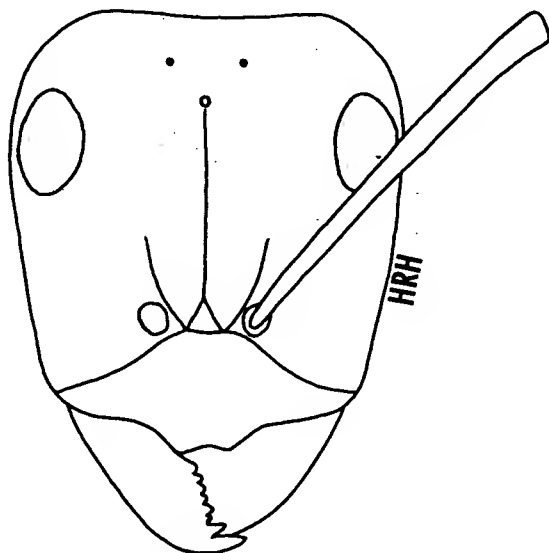
9. Scapes short and robust, shorter than head length; mandibles weakly striate, shining; petiole rather narrowly fan shaped, the crest blunt

emeryi Wheeler.

Scapes longer than head length, more slender; mandibles strongly striate; petiole broadly fan shaped and with a sharp, sinuate crest

subnuda Emery.

I have not as yet discussed the question of the validity of *Raptiformica* as a subgenus even though I have used the name throughout the treatment of the ten Nearctic species now known. Creighton (1950) used the name even though he followed previous authors in including the misplaced species *bradleyi*, *perpilosa*, *manni*, *oregonensis*, and *obtusopilosa*. Wilson and Brown (1955) synonymized the name under *Formica*, *sensu stricto*, even though they had freed the *sanguinea* group from these inclusions. Gregg (1963) essentially made an uncritical return to Creighton's 1950 viewpoint without presenting anything new as a scientific basis.

**Fig. 1****Fig. 2****Fig. 3**

- Fig. 1. Outline of thoracic dorsum, *Formica (Raptiformica) subintegra* Emery; length of thorax, 2.54 mm, in specimen depicted.
- Fig. 2. Outline of thoracic dorsum, *F. (Raptiformica) rubicunda* Emery; length of thorax, 3.50 mm, in specimen depicted.
- Fig. 3. Head of *F. (Raptiformica) creightoni* Buren, n. sp.; length of head (excluding mandibles) 1.85 mm, width of head, 1.65 mm, in specimen shown.

My own viewpoint is that the *sanguinea* group is distinct enough for the valid useage of *Raptiformica* as a subgeneric name. Furthermore, it is the only group within *Formica* (if the obviously unrelated true representatives of *Proformica* are excluded as a separate genus) that appears to deserve this distinction. Freed of extraneous species, the *sanguinea* group can now be seen as an extremely closely knit group, with several unique combinations of features not found in any other species of *Formica*, and without any hint of being at all closely related to any other species of *Formica*.

These points should be considered.

1. The nest founding of the *sanguinea* group, in so far as have been studied, forceably enter small colonies of the host species, appropriate host brood, and kill or drive off host workers before rearing the host brood. This habit appears to be unknown throughout the remainder of *Formica*. There are at least four or five more or less separate groups within *Formica* such as the *microgyna*, *exsecta*, *ciliata*, *dakotensis*, and (in part) *rufa* groups all of which are known or strongly suspected of temporary or in one case of permanent social parasitism. In these, however, the females are probably adopted by the host workers, so far as is known, or in so far as may be postulated from the size and structures of the female. Page 40

2. The *sanguinea* group is the only group within *Formica* in which at least the better studied species are known to regularly conduct slave raids. There is no hint of this habit throughout the remainder of *Formica*.

3. Certain morphological characteristics, when considered as a group, delimit *Raptiformica* almost without fail. The clypeal notch, while variable in depth, is always present and is noticeable throughout all sizes of the workers. The integument is always rather opaque. The pubescence is always dense, at least on the gaster. Except in one concolorous species, the head and thorax are reddish brown or yellow and the gaster is brown or black. The metanotum is nearly always distinct. The petiolar scale is always fan shaped seen from behind and a mid-dorsal notch is usually present.

4. In one morphological feature, the weak flattening of the terminal joints of the antennae, *Raptiformica* seems unique. I have been unable to find this character throughout the remainder of *Formica* or in related genera. All species of *Raptiformica* as presently restricted have this character.

So, in spite of the fact that the clypeal notch is not unique to *Raptiformica*, being shown also by certain *neogagates* group species and by *Proformica nasuta*, this character in combination with other characters, including one previously overlooked feature which does appear to be unique, plus the unique habits of the species, gives very strong argument to the validity of this subgenus.

No such argument can be advanced for other subgenera which have been proposed for *Formica*, namely *Serriformica*, *Coptoformica*, and *Ncoformica*, and I follow Creighton in regard to the first two. *Neoformica* Wheeler must also be dropped as untenable. Such species as *F. moki* Wheeler and *F. archboldi* Smith are clearly transitional to the *fusca* group in *Formica*, *s. str.* and there can be no possibility of adequately delimiting characterization.

The question of *Proformica* is of a different order of magnitude. The mandibular dentition of *F. nasuta* is very different from any of the *neogagates* group or any other species or species group properly assigned to *Formica*, *s. str.* or *F. (Raptiformica)*, as I have already shown. This dentition is also different from that occurring in other related genera such

as *Lasius*, *Myrmecocystus*, and *Cataglyphis*. On the basis of this one important character alone, there seems little question but that *Proformica* deserves to rank as a separate genus. Fortunately for taxonomic consideration, several other almost equally important characters give overwhelming weight to the argument.

1. The parameres of the male genitalia of *Proformica nasuta* are extremely long and slender and extend at least one-fourth of their length beyond the stipes. Although there is some variation within *Formica*, in no species do the male genitalia really match or approach this condition.

2. The second and third joints of the funiculi in *P. nasuta* are extremely short and together are distinctly shorter than the first joint. Moreover, the joints gradually increase in length from the second to the penultimate, thus being similar to the condition in *Lasius*. None of the species of *Formica*, including those in the *neogagates* group, really match this condition. In *Formica* the second to the penultimate joints are all very nearly equal in length or else the more basal joints are slightly longer than those more terminal.

3. In *P. nasuta* the thorax has a different structure than in *neogagates* and throughout *Formica* without exception. The mesonotum is straight above in profile in *P. nasuta* whereas it is convex in *neogagates* and all other species of *Formica* s. str. and *F. (Raptiformica)* and becomes a part of the nearly hemispheric-like curve formed by the pronotum and mesonotum together. Seen from above, the mesonotum is very broad in *P. nasuta*, almost as broad as long and nearly as broad as the propodeum. In *Formica*, including the *neogagates* group, the mesonotum is always much longer than broad, seen from above, and is always much narrower than the propodeum.

Thus there are at least four major differences between *P. nasuta* and *Formica*, and only superficial resemblances, such as small size, shining integument, and sparse pubescence, to any of the nearctic species of *Formica*, namely *neogagates*, *lasioides*, and *linata*, formerly misplaced in *Proformica*. Several of the Palearctic species placed in *Proformica* are unavailable and a revision of this genus cannot be attempted. From the limited material available in the U.S., I would judge that *P. leferense* Wheeler, *P. coriacea* Kusnezov, *P. nasuta ferrerii* Bondroit, *P. epinotalis* Emery, *P. jacoti* Wheeler, *P. frigida* Dlussky, *P. alpina* Mayr., *P. splendida* Dlussky, *P. pilosiscapa* Dlussky, *P. nitidior* Forel, *P. mongolica* Emery, and possibly *P. aberrans* Mayr are all bonafide members of *Proformica*. These all have the same mandibular dentition as *P. nasuta* and in general, match the other characters of antennal and thoracic structure.

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